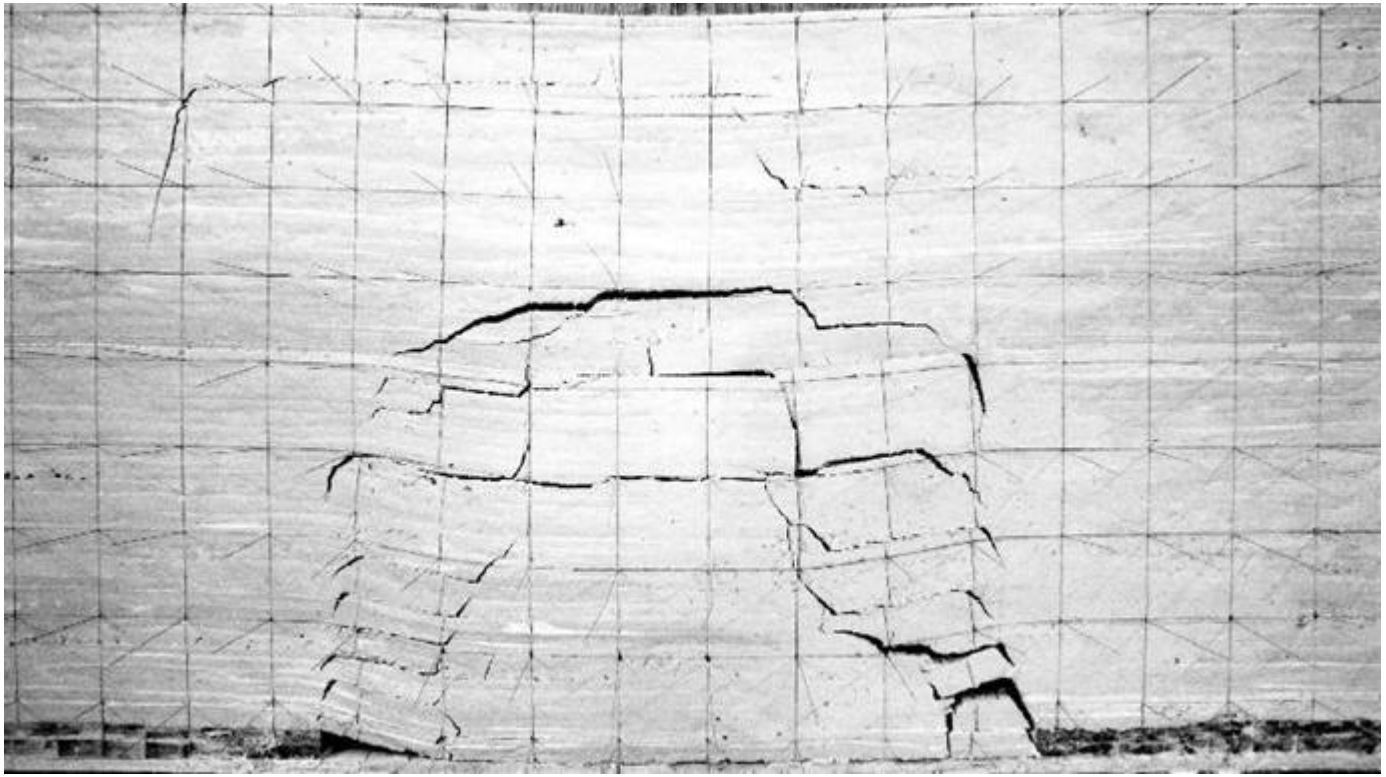
Drainage of gas emissions induced by mining (post-drainage)

- Basics
- Arrangement and sealing of the drainage boreholes (gas quality, gas volume)
- Pipes and pumps
- Monitoring
- Case study

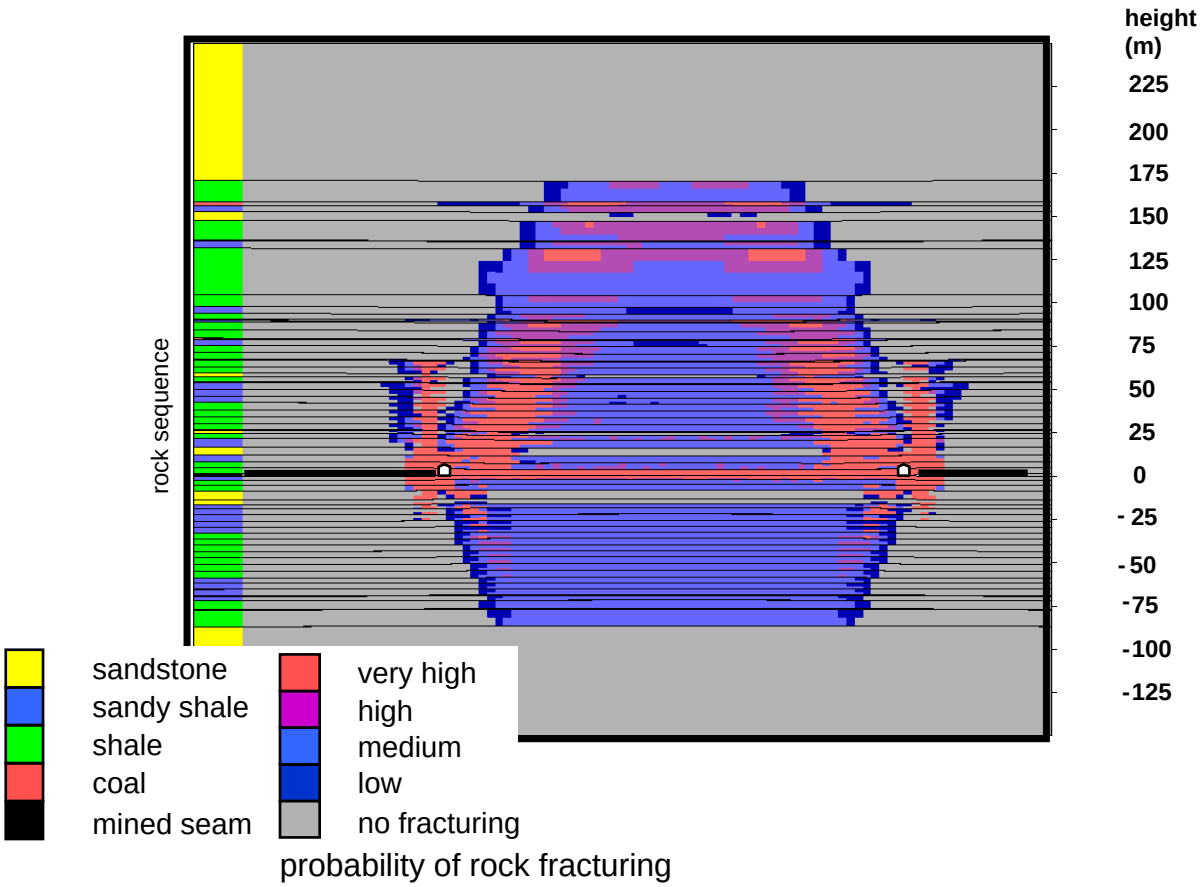
Basics

- Low permeability of the coal seams (<0.1 mD) and disadvantageous geologic features (soft coal, faults) in many coal basins
- Fracturing and permeability enhancement caused by caving the strata by coal exploitation
- Gas from the accompanying seams above or below the worked seam
- Often much higher gas flows from roof and/or the floor (additional gas emissions) than from the worked seam (basic gas emissions)

1. Vertical model section parallel to the longwall face showing the fracturing of strata in the roof (modelled after GASKELL 1989)



2. Fracturing of the rock sequence in the roof and the floor of a longwall operation (vertical section) based on a numerical simulation



3. Plastification and relief of mechanical pressure in the area of fracturing around a longwall operation with a thick, hard sandstone layer in the roof

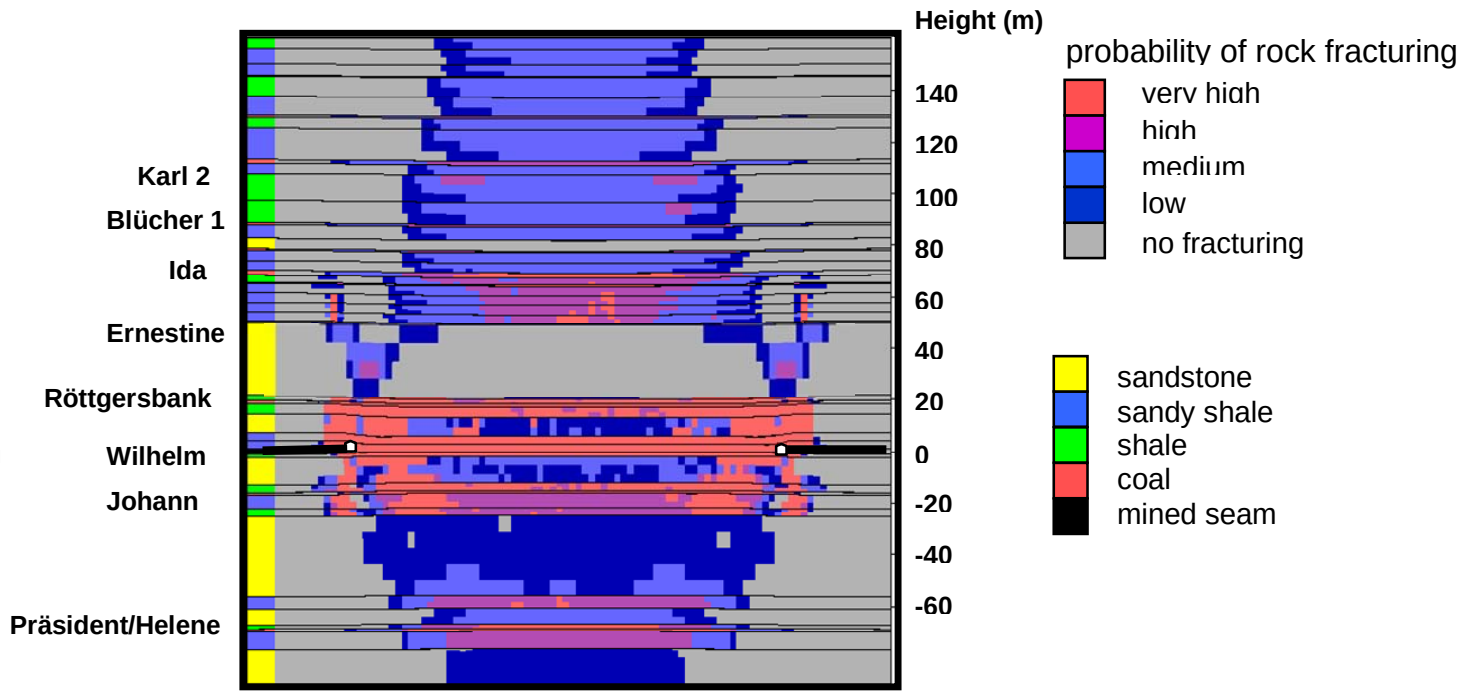
Given conditions:

depth: 1460 m

length of longwall: 340 m

total worked thickness of seam Wilhelm: 2,20 m

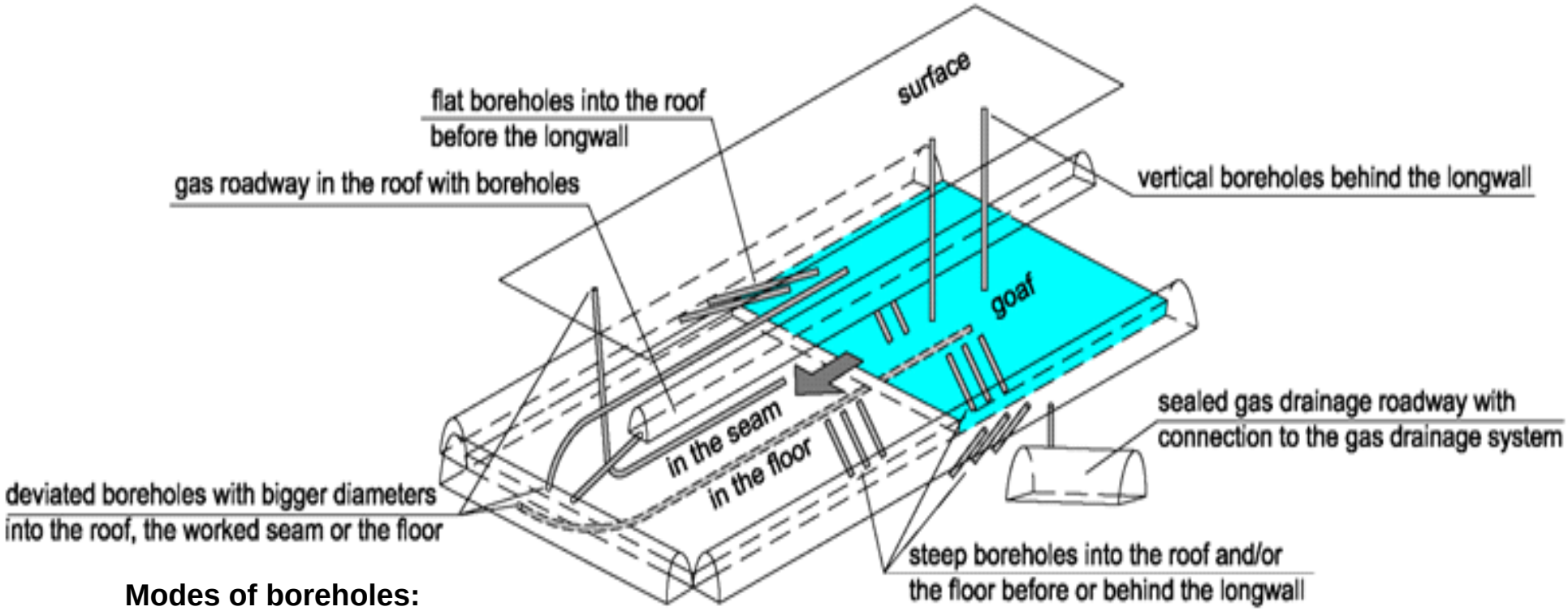
dip angle: 0 gon



Arrangement and sealing of drainage boreholes

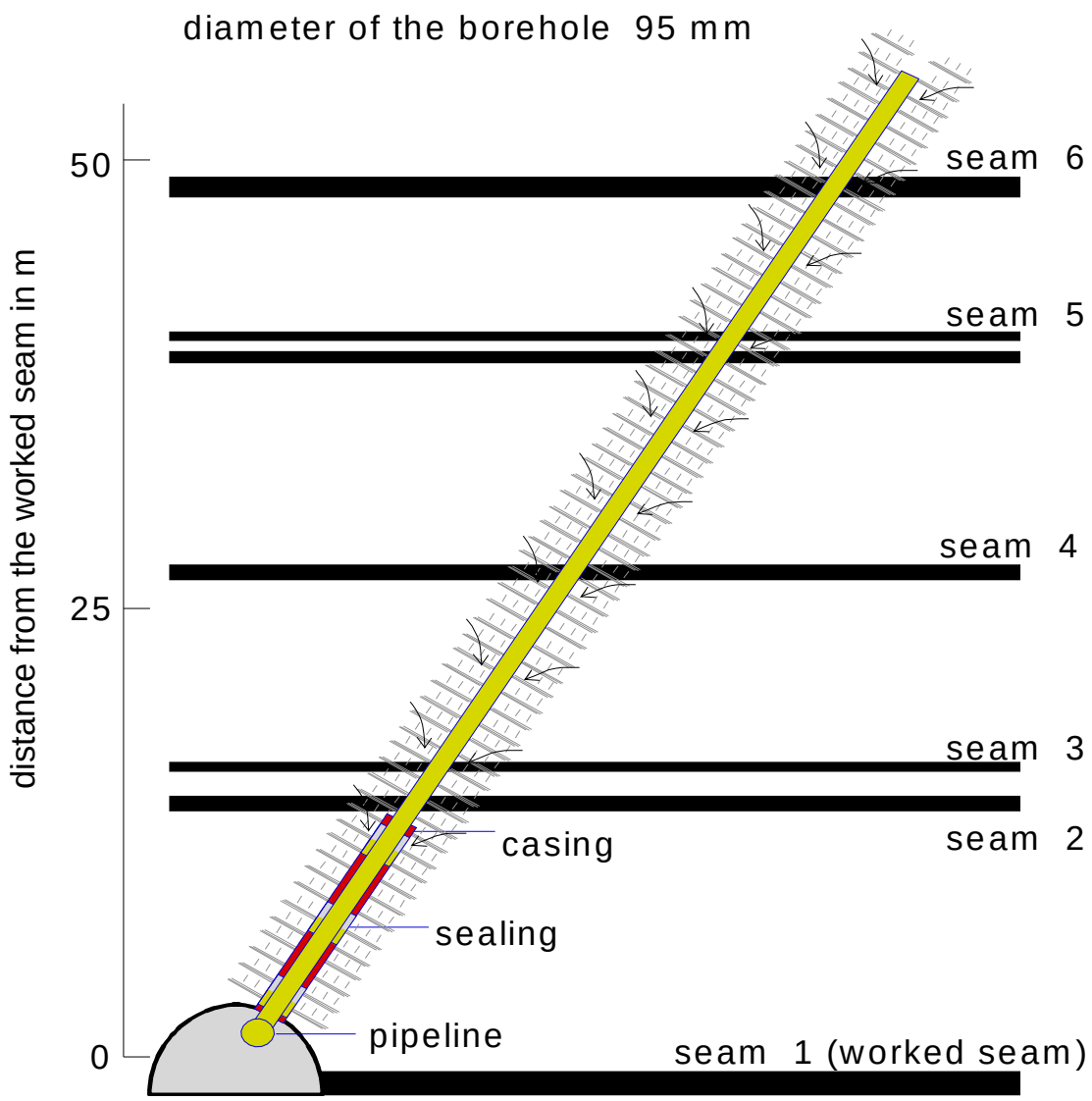
- Modes of boreholes
- Sealing of the first 5 to 10 meters of the boreholes
- Regulation of every individual borehole
- Careful connection between boreholes and pipeline
- Avoiding leakages to the goaf or other boreholes
- Consequences for ventilation layout

4. Various post-drainage drilling methods

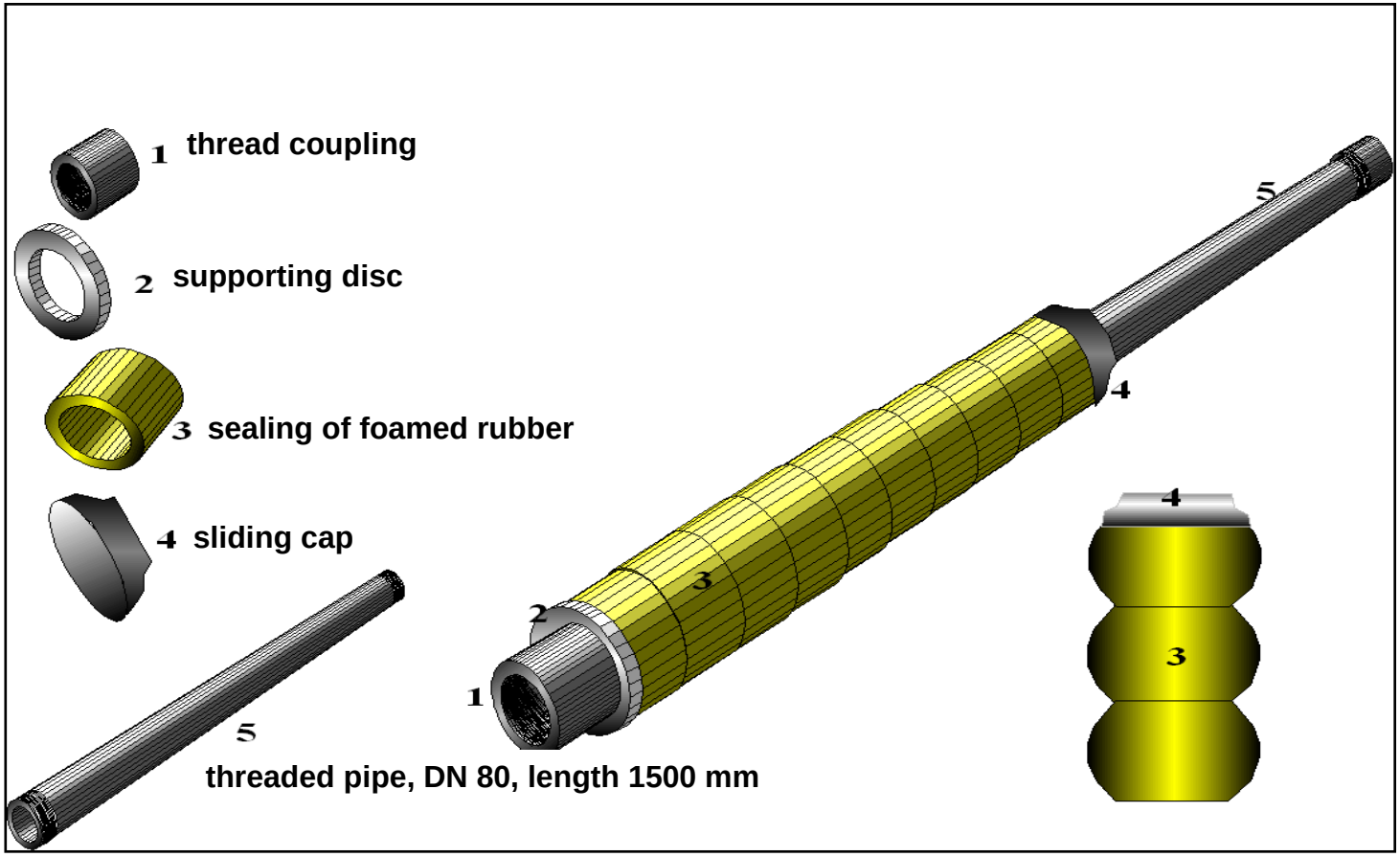


Modes of boreholes:
- **guided horizontal boreholes**
- **gas roadway with connection via borehole(s)**
- **cross measure boreholes**
- **surface goaf boreholes**

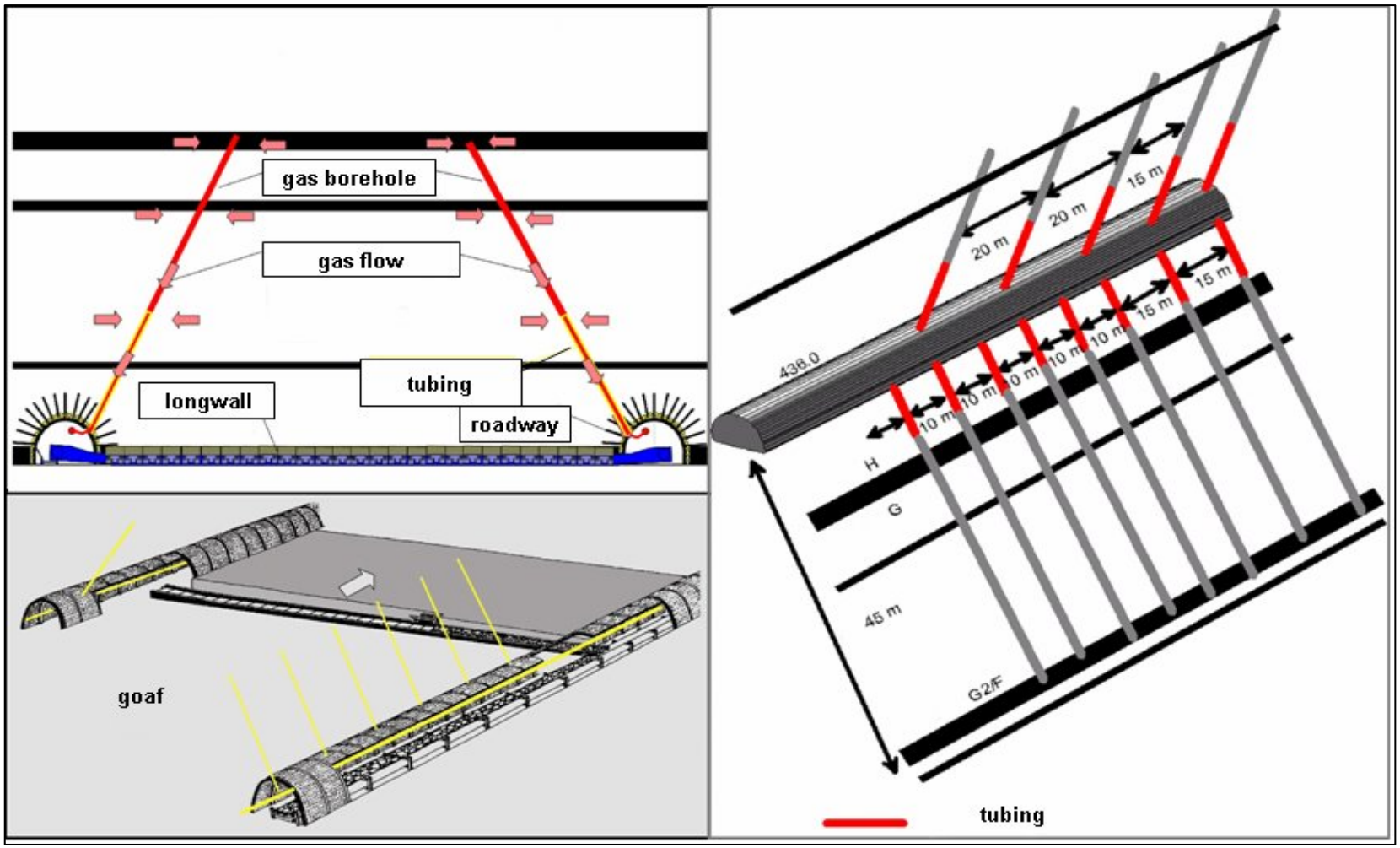
5. Gas drainage borehole in the roof of a longwall (classic method)



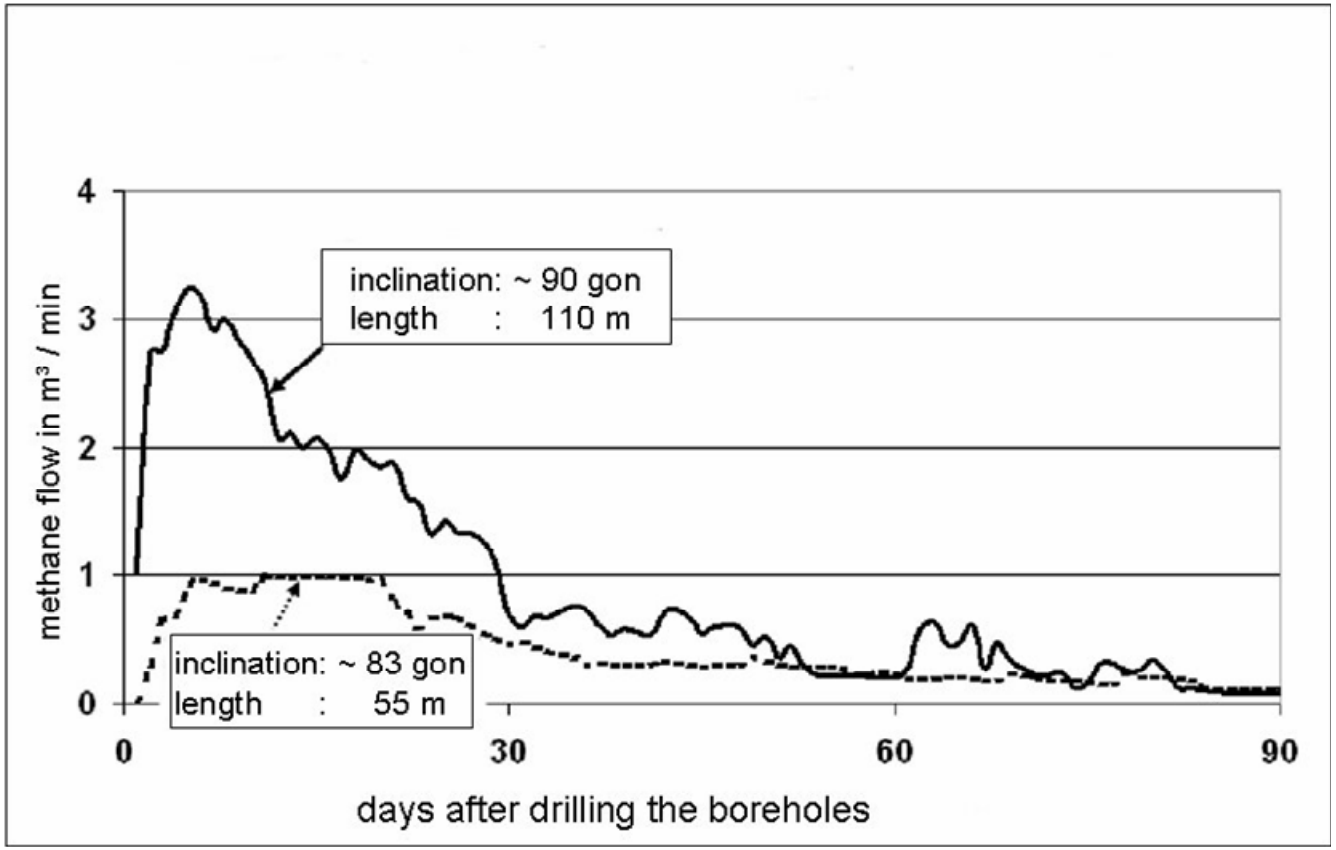
6. Casing and sealing of a gas drainage borehole (developed by DSK)



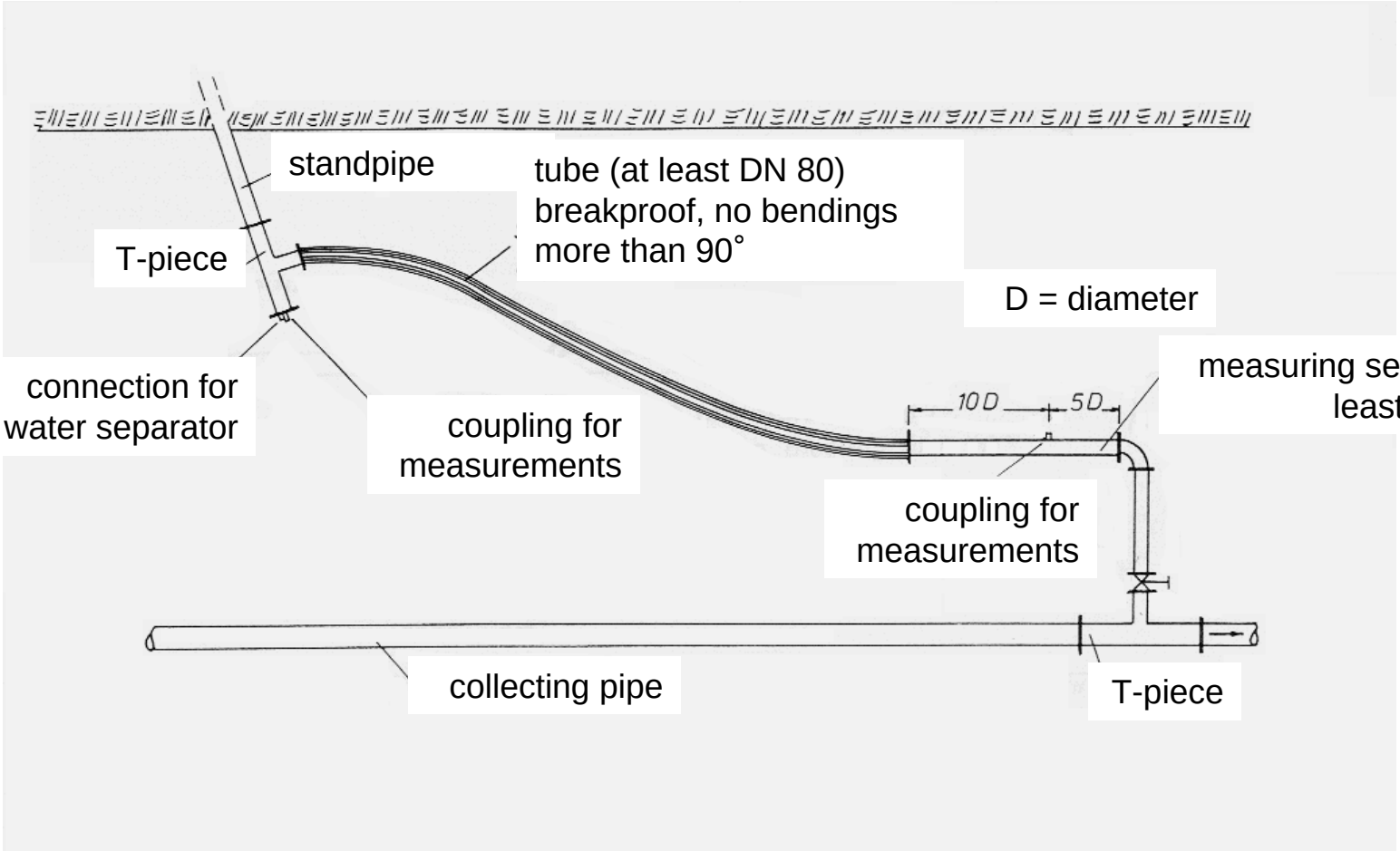
7. Basic draft for gas drainage boreholes (schematic diagramms)



8. Increase of gas emissions in the case of incline and length modification of the gas boreholes

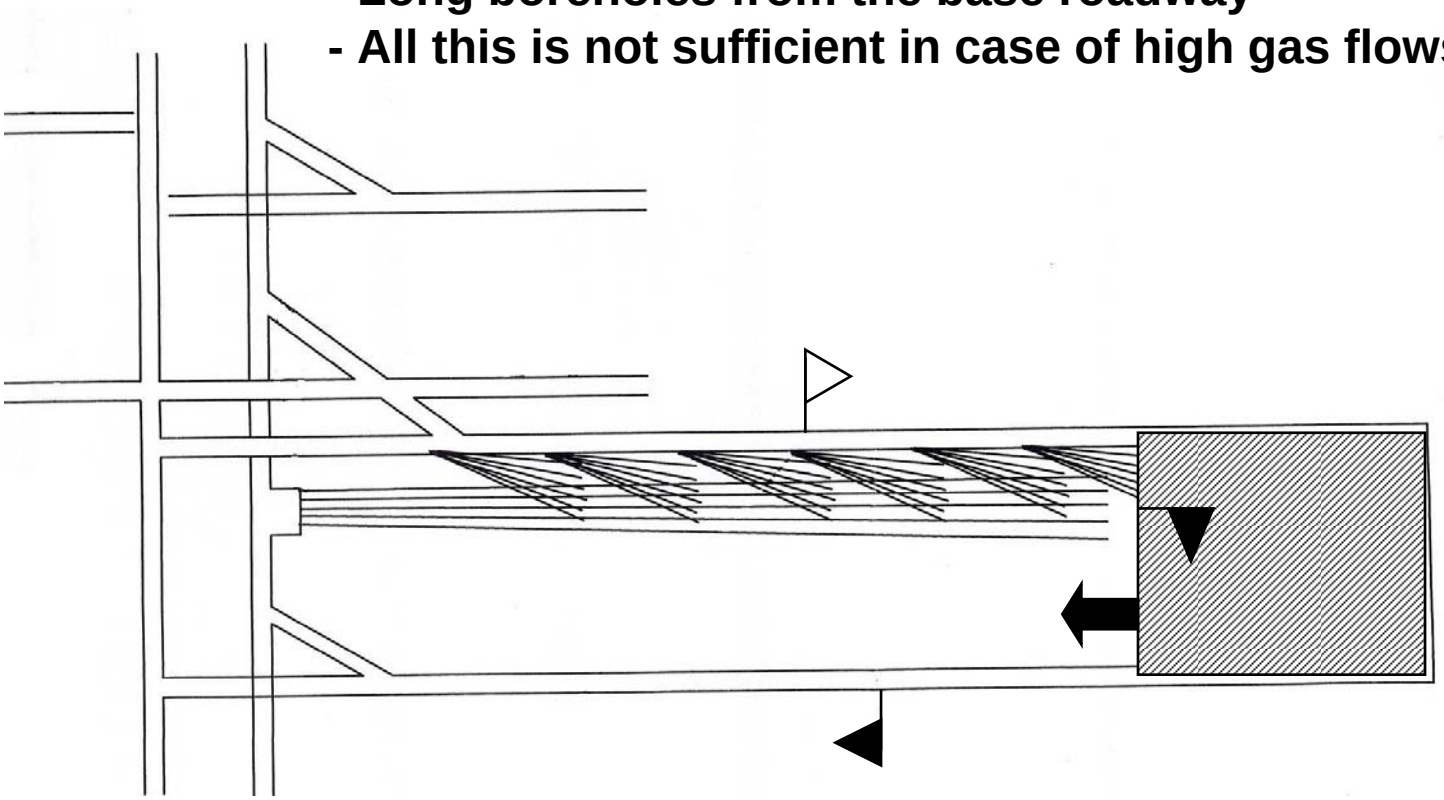


9. Connection between borehole and pipeline



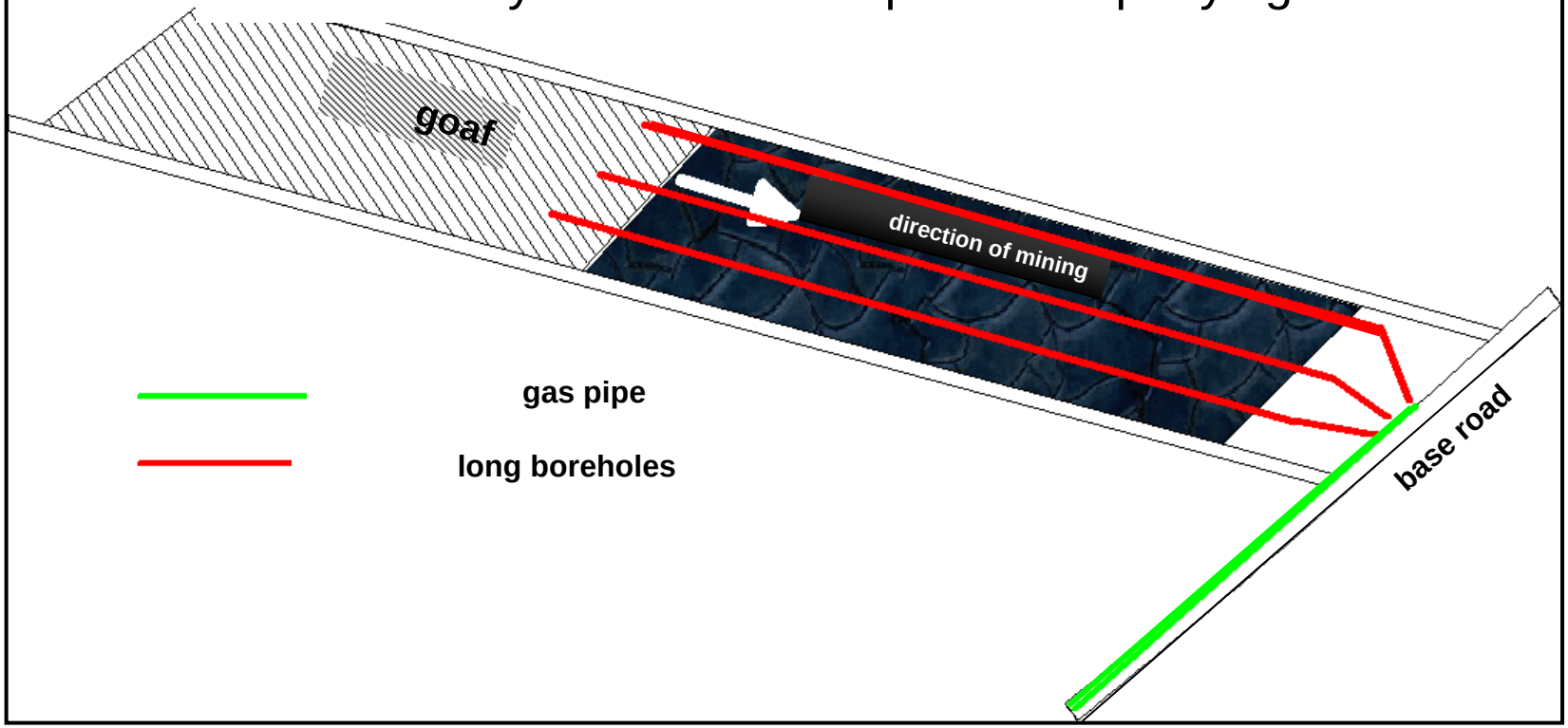
10. Retreat workings with fans of drainage boreholes, drilled from one point

- Short productive time of the boreholes from the roadways
- leakages with the air stream, therefore low concentrations
- Long boreholes from the base roadway
- All this is not sufficient in case of high gas flows



11. Horizontal gas drillings

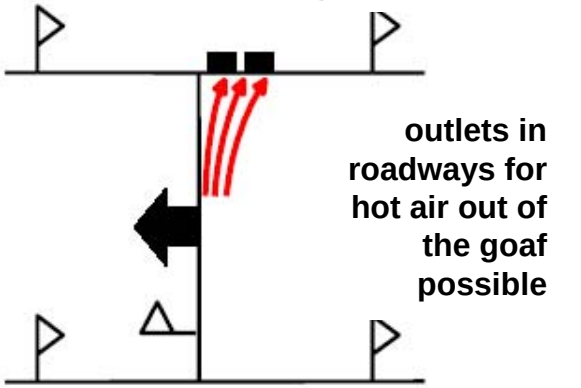
Out of a base road: 30 m in the roof towards the approaching longwall face;
High operating expense;
Low efficiency in case of multiple accompanying seams



12. Pros and cons of the different ventilation systems in mine air conditioning

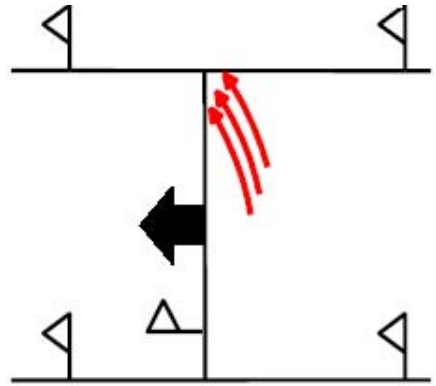
advantageous

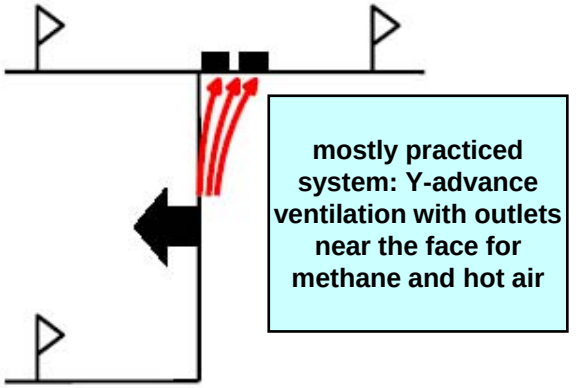
disadvantageous



outlets in roadways for hot air out of the goaf possible

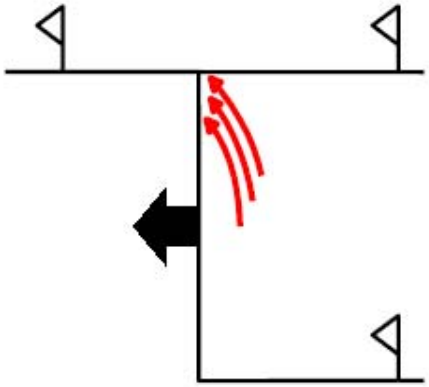
H





mostly practiced system: Y-advance ventilation with outlets near the face for methane and hot air

Y



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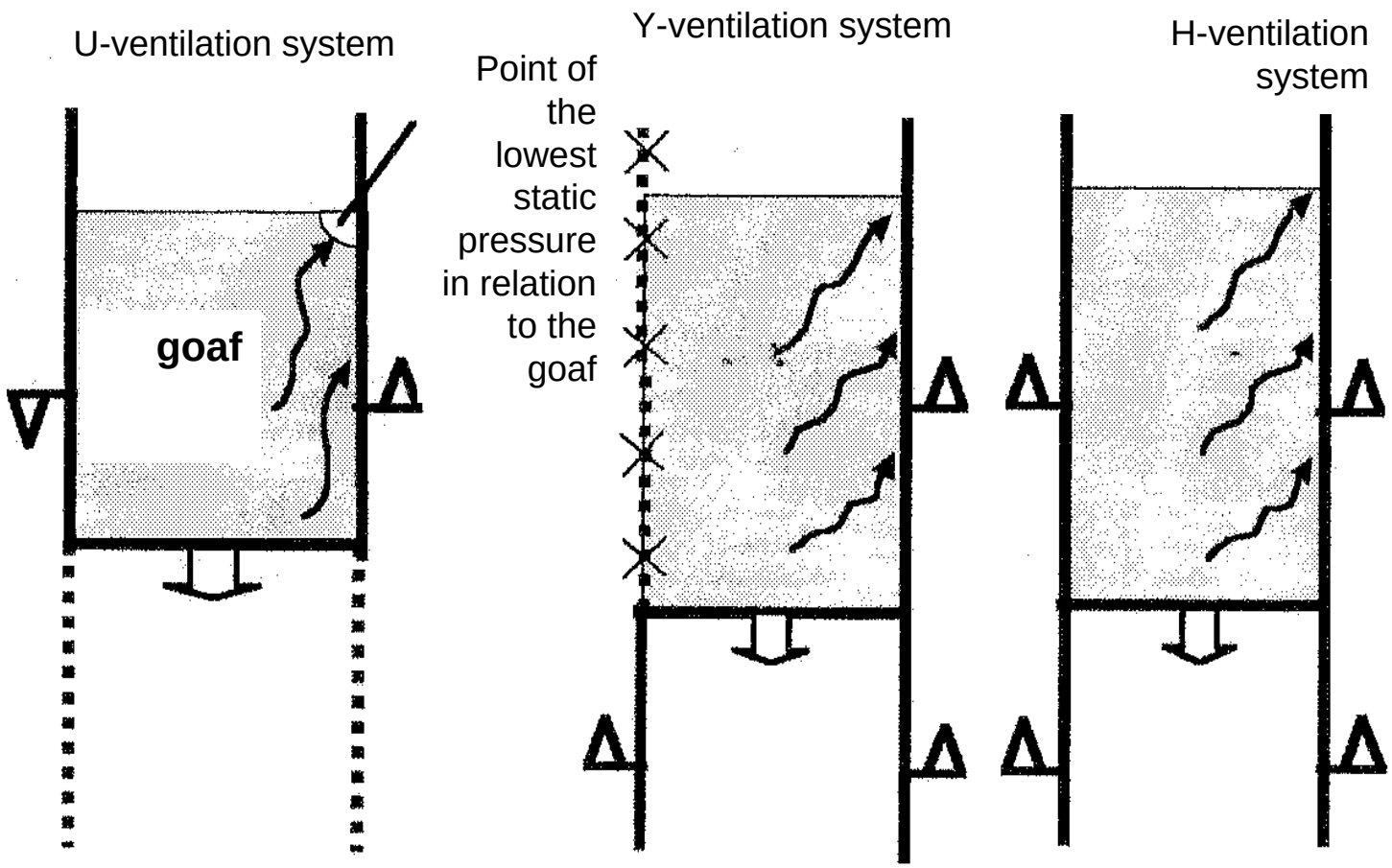
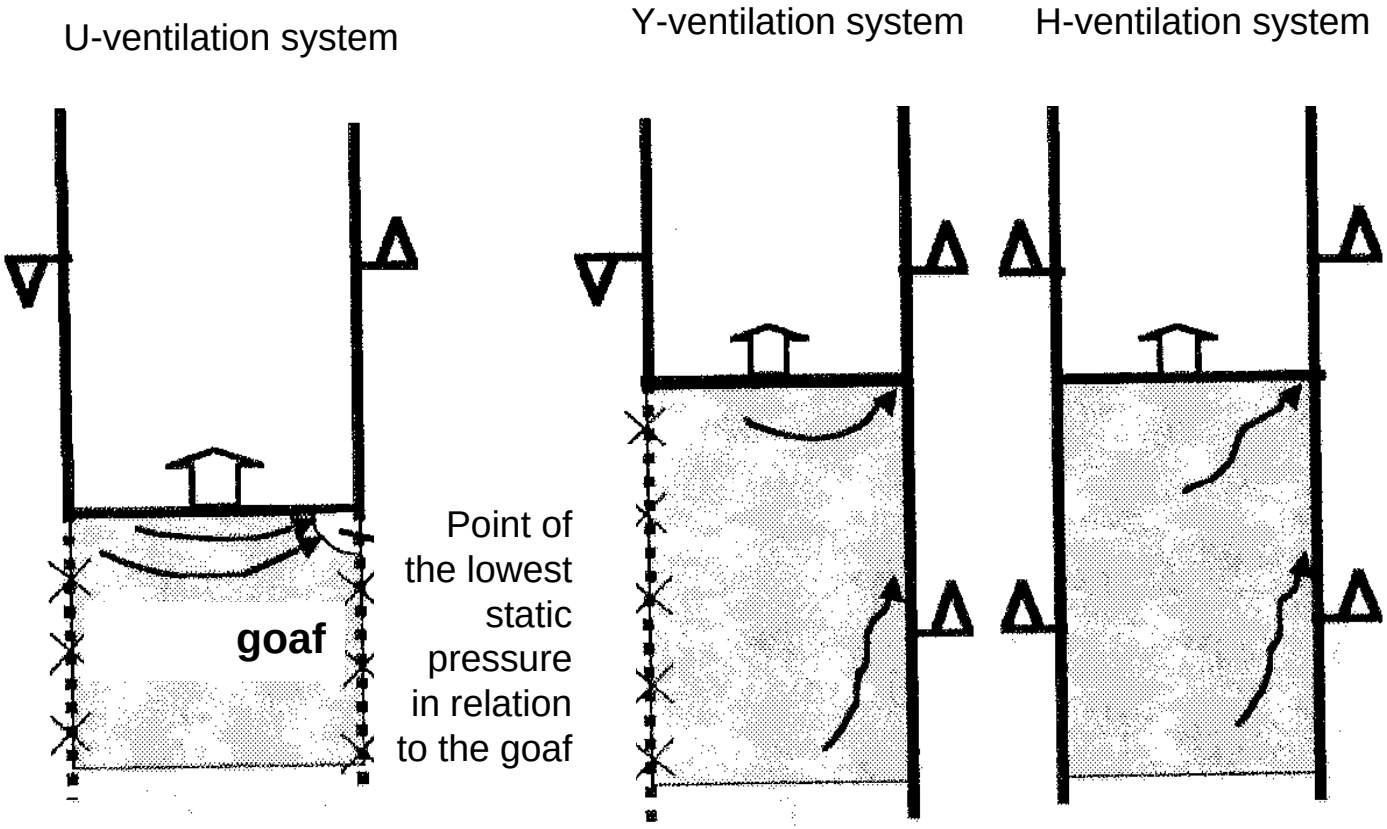
13. Ventilation design in the case of advanced working



14. Ventilation design in the case of retreat working



15. Efficiency of gas drainage at different ventilation design

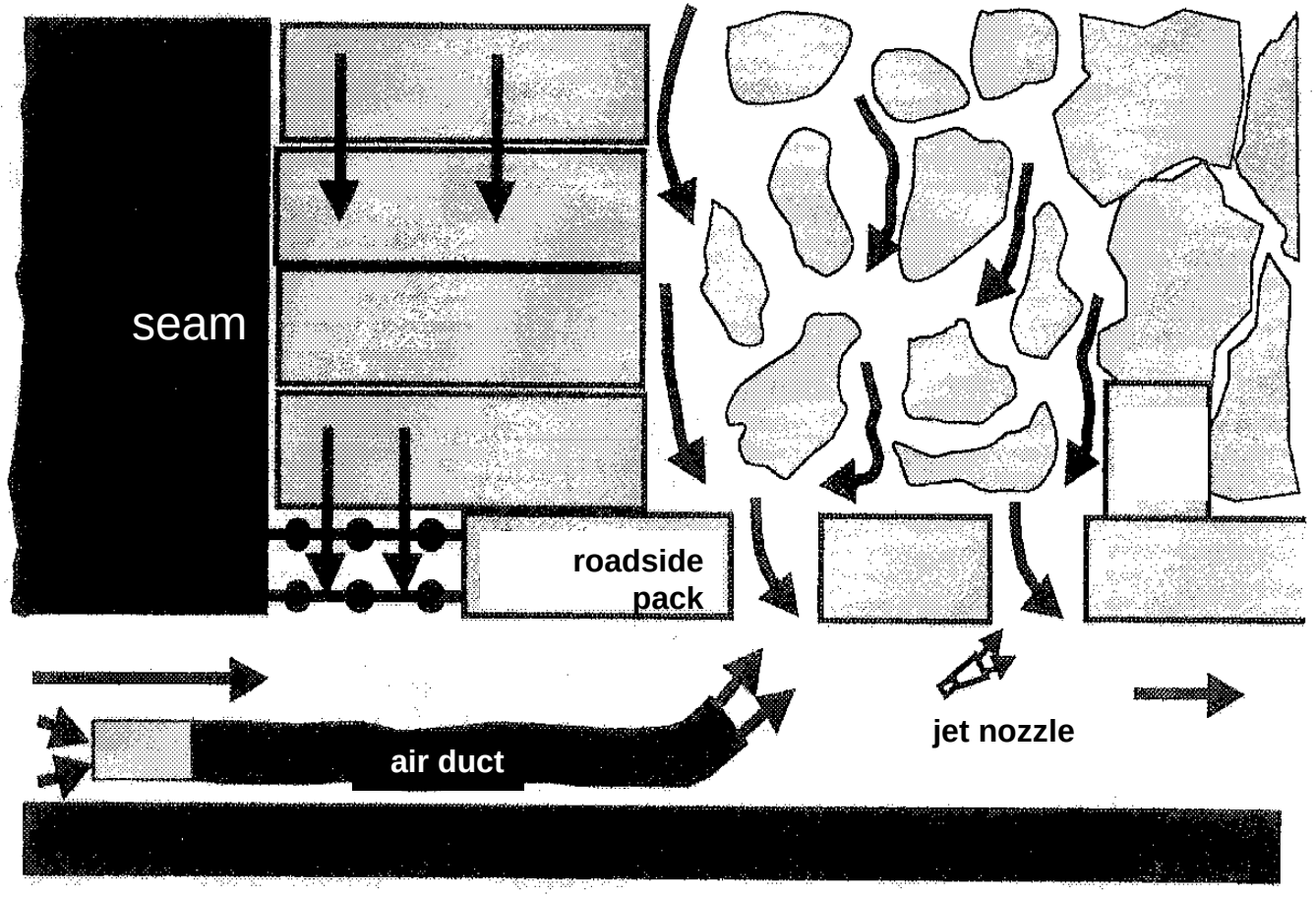
1. Y-ventilation system in combination with advanced working

- Efficiency of the gas drainage up to 80 %
- Must be operated in the case of high gas contents in the coal
- Boreholes can be drilled directly behind the longwall
- Boreholes are relatively short
- Stability of the boreholes is assured over the whole period of winning
- If necessary various boreholes can remain under active suction

2. U-ventilation system in combination with retreat working

- Efficiency of the gas drainage up to 30 %
- Length of the boreholes is comparatively high
- Boreholes are lost after the passage of the longwall for lack of access
- Short lifetime of the boreholes
- Depending on position and distance only 5 up to 8 boreholes are under suction

16. Separation of air flow through the longwall and leakages behind the shield support by window-technics

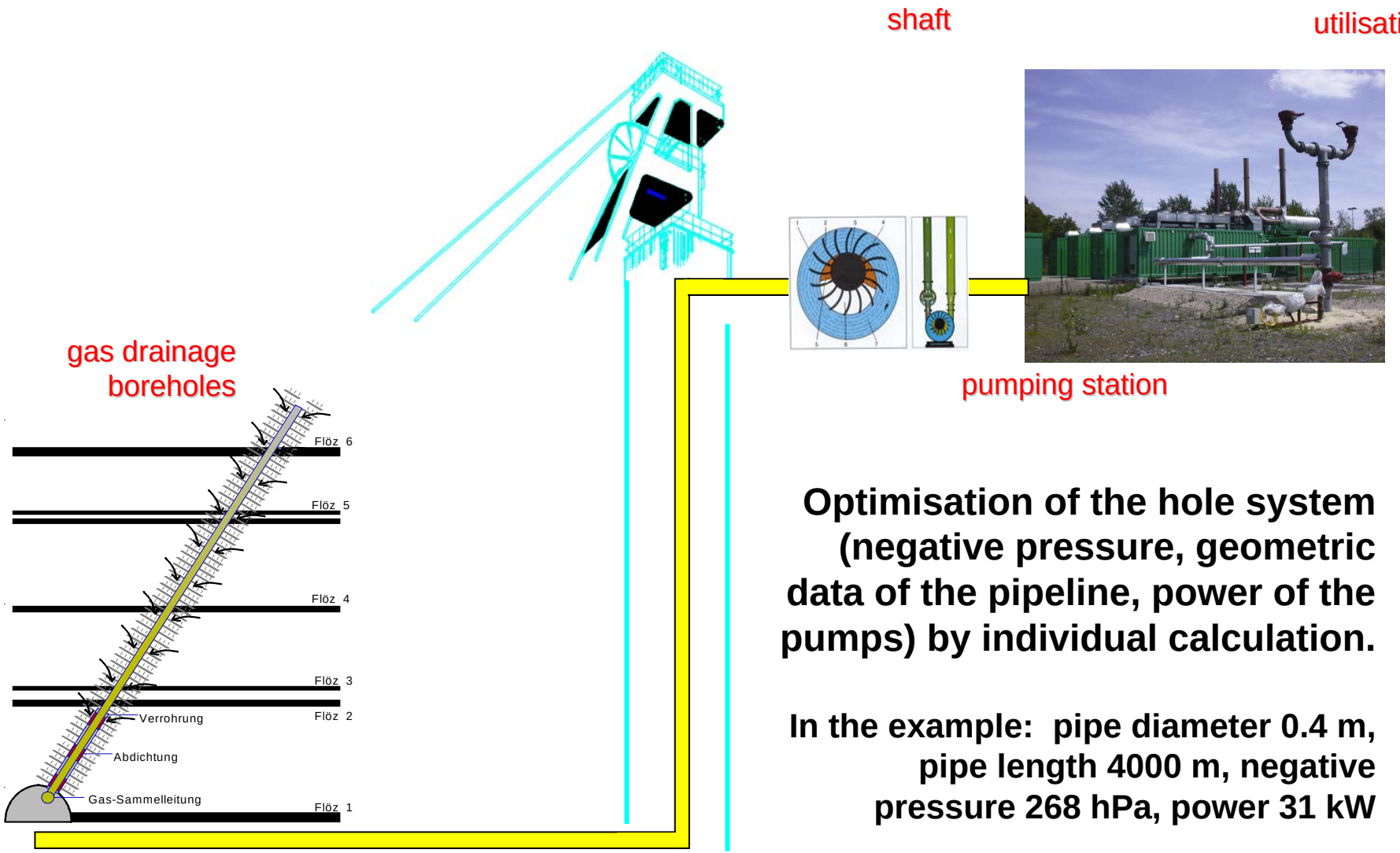


Pipes and pumps

- Optimisation of the hole system from the boreholes to the pumping station
- Taking into account the expected volume of gas flow calculated by prediction method
- Don’t spare with the diameters! The possibility of compensating a small diameter by higher negative pressure is limited and energy consuming!
- Avoid leakages!
- Water separation

17: Gas drainage in the roof:

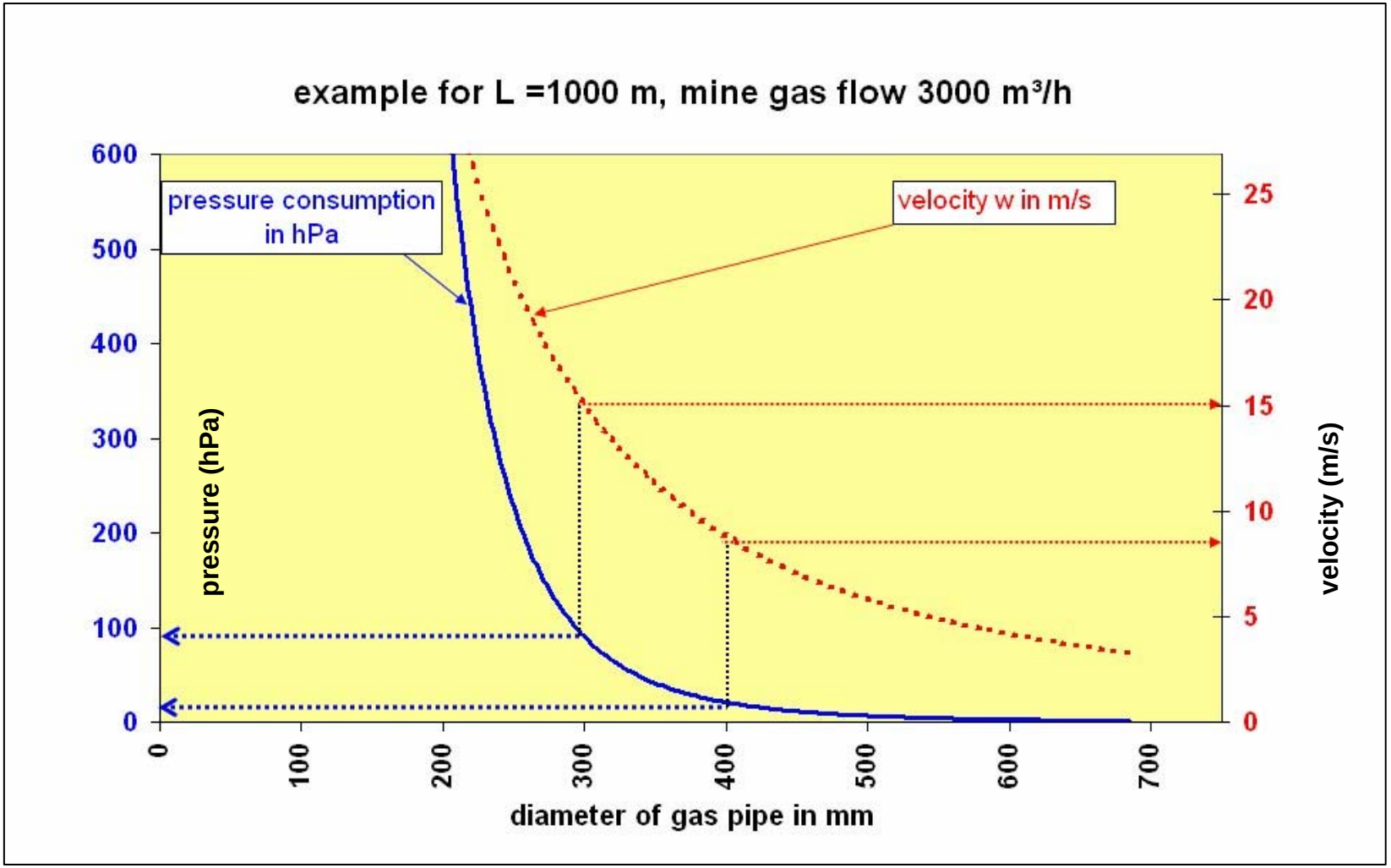
From the borehole to utilisation



Optimisation of the hole system (negative pressure, geometric data of the pipeline, power of the pumps) by individual calculation.

In the example: pipe diameter 0.4 m, pipe length 4000 m, negative pressure 268 hPa, power 31 kW

18. Pressure consumption depending on pipe diameter



19. Gas exhausters at Prosper-Haniel mine

4 x 4.500 Nm^3 / h, together 300 Nm^3/min

Monitoring

- At every drainage borehole measurements of gas flow volume, methane concentration and negative pressure must be carried out at least once a week.
- In pipelines the concentrations of methane and carbon monoxide must be measured twice a week (interval at least two days)
- as well as gas flow volume and negative pressure in maximum intervals of one week.
- In main pipes (before their redirection to the surface) methane concentration and – if necessary – gas flow volume and negative pressure must be measured in intervals of two weeks.

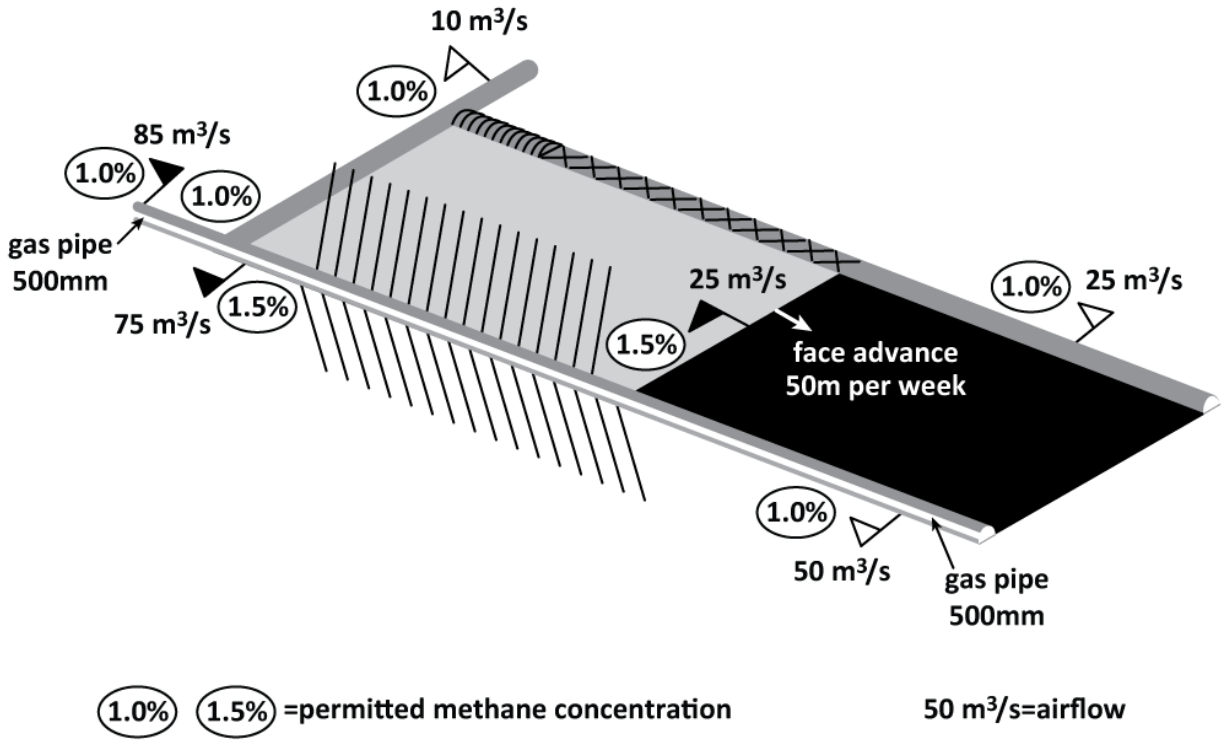
Case study (p. 1)

- High performance operations in areas with high gas emissions
- Maximum methane flow expected 112.5 m^3/min
- Maximum air flow across the longwall 1500 m^3/min dilutes 22.2 m^3/min methane (exceptional methane concentration limit of 1.5 %)
- Reduction of safety due to this exception is compensated by enhanced monitoring and gas drainage
- Y-shaped ventilation design with advancing coal face
- Introducing further 3000 m^3/min of air
- Cross-measure boreholes behind the longwall face

Case study (p. 2)

- High gas purity and high effectiveness of the drainage boreholes (70% of roof gas, 40% of floor gas)
- Seals along the goaf side of the open roadway
- Limiting concentration outbye of the return air stream was 1 %
- With an air volume of 5100 m^3/min (additional 600 m^3/min from the basal roadway of the longwall)
- Planned production of 4000 t/d could be achieved
- The increase of productivity exceeds the additional costs (open roadway,gas drainage, sealing along the open roadway)

21. Case study: Arrangement of gas boreholes and air supply of a longwall with a Y-shaped ventilation system



22: Optimisation of the control of gas emissions in underground hard coal mines with regard to safety and productivity;

Influence of gas drainage on the productivity in the outlined example

Additional costs by

gasdrainage	1.8 Mill. €
open roadway (2000m)	4.0 Mill. €
road side pack	1.0 Mill. €
in total	6.8 Mill. €

Production

without the measurements	1006 t/d
including the measurements	4308 t/d
difference	3302 t/d

Productivity

output	+ 0.8 Mill. t/a coal
input	+ 6.8 Mill. €